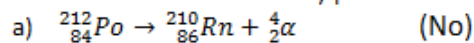


Alpha, Beta, and Gamma Decay

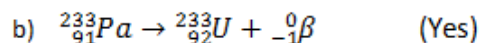
1) Determine whether these decay processes are possible.



Charge: $84 \neq 86 + 2$

Atomic Mass number: $212 \neq 210 + 4$

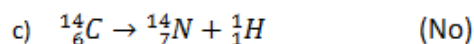
This equation violates the laws of conservation of charge and of atomic mass number. Therefore, this decay process is impossible.



Charge: $91 = 92 - 1$

Atomic mass number: $233 = 233$

This equation is correct—both mass number and charge are conserved. Therefore, this decay process is possible.



Charge: $6 \neq 7 + 1$

Atomic mass number: $14 \neq 14 + 1$

This equation violates the laws of conservation of charge and of atomic mass number. Therefore, this decay process is impossible.

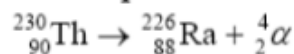
2) Write the α -decay process for these elements, and name the parent and daughter elements.

All alpha decay processes fit the pattern ${}_Z^AX \rightarrow {}_{Z-2}^{A-4}Y + {}_2^4\alpha$.



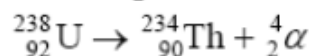
For thorium-230, the daughter element is ${}_{90-2}^{230-4}\text{Y} = {}_{88}^{226}\text{Y}$.

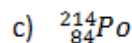
On the periodic table, the element with $Z = 88$ is radium.



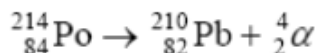
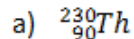
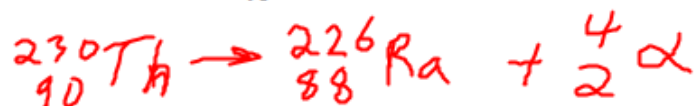
For uranium-238, the daughter element is ${}_{92-2}^{238-4}\text{Y} = {}_{90}^{234}\text{Y}$.

On the periodic table, the element with $Z = 90$ is thorium.





[polonium, lead]

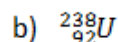
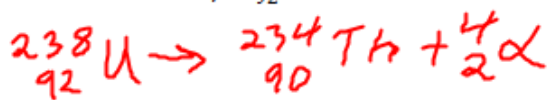
For polonium-214, the daughter element is ${}^{214-4}_{84-2}\text{Y} = {}^{210}_{82}\text{Y}$.On the periodic table, the element with $Z = 82$ is lead.3) Calculate the energy released during α -decay of these nuclei:[7.641 x 10⁻¹³ J]

$$230.033134\text{u} \rightarrow 226.025410\text{u} + 4.002603\text{u}$$

$$230.033134\text{u} \rightarrow 230.028013$$

$$\Delta m = 5.121 \times 10^{-3}\text{u} \left(\frac{1.66 \times 10^{-27}\text{kg}}{\text{u}} \right) = 8.50086 \times 10^{-30}\text{kg}$$

$$E = mc^2 = 8.50086 \times 10^{-30} (3.00 \times 10^8)^2 \quad \boxed{E = 7.651 \times 10^{-13}\text{J}}$$

[6.839 x 10⁻¹³ J]

$$238.050788 \rightarrow 234.043601 + 4.002603$$

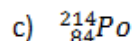
$$E = \Delta mc^2$$

$$238.050788\text{u} \rightarrow 238.046204\text{u}$$

$$E = 7.60944 \times 10^{-30} (3.00 \times 10^8)^2$$

$$E = 6.848 \times 10^{-13}\text{J}$$

$$\Delta m = 4.584 \times 10^{-3}\text{u} = 7.60944 \times 10^{-30}\text{kg}$$

[1.255 x 10⁻¹² J]

$$213.995201\text{u} \rightarrow 209.984189\text{u} + 4.002603\text{u}$$

$$213.995201\text{u} \rightarrow 213.986792\text{u}$$

$$E = \Delta mc^2$$

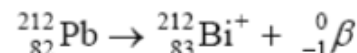
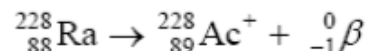
$$\Delta m = 8.409 \times 10^{-3}\text{u} = 1.395894 \times 10^{-29}\text{kg}$$

$$E = 1.395894 \times 10^{-29} (3.00 \times 10^8)^2$$

$$E = 1.256 \times 10^{-12}\text{J}$$

4) Find the elements produced by β^- decay of:

Use the pattern ${}_Z^AX \rightarrow {}_{Z+1}^AX + {}_{-1}^0\beta$. The atomic number must increase by one without changing the atomic mass number.



5) For thallium-202:

a) What isotope will β^+ decay of thallium-202 produce? [mercury-202]

During β^+ decay, the atomic number decreases by 1. When the atomic number of thallium decreases by 1, it becomes $Z - 1 = 81 - 1 = 80$, which is the atomic number for mercury.



Use the general pattern ${}_Z^AX \rightarrow {}_{Z-1}^AY + {}_{+1}^0\beta + \nu$ for β^+ decay: ${}_{81}^{202}\text{Tl} \rightarrow {}_{80}^{202}\text{Hg} + {}_{+1}^0\beta + \nu$

c) How much energy will be released by the decay of the thallium-202 nucleus if the mass of the thallium nucleus decreases by 0.001 463 u? [0.3400 MeV]

$$\Delta m = 0.001463 \text{ u} - 2(5.485799 \text{ u} \times 10^{-4})$$

$$\Delta m = 3.658402 \text{ u} \times 10^{-4}$$

$$E = 3.658402 \text{ u} \times 10^{-4} (931.5 \text{ MeV/u})$$

$$E = 0.3408 \text{ MeV}$$

6) Identify each type of decay in this series, and name the parent and daughter elements.

